SVS LOGI - a software for Saint-Venant system - installation and reference manual

Hassan Belghazi, Alexis Cuglietta, Emilien Dessalles, Fabien Marrone, Imade Merzoug, Chiara Simeoni

Saint-Venant System

Installation and Reference Manual

Hassan BELGHAZI, Alexis CUGLIETTA, Emilien DESSALLES, Fabien MARRONE, Imade MERZOUG, Chiara SIMEONI

Table of Contents

Abstract.. 3

First part:

1.1 **Saint-Venant equations**..4

1.2 **Kinetic Schemes for the Saint-Venant equations**.........................7

1.3 **The experimental framework**..10

Second part:

2.1 **Implementation part**... ...11

2.2 **Graphic part**...11

HANDBOOK 12

Bibliographic references 55

Abstract

This report describes a numerical software for the simulation of shallow water flows by means of the hyperbolic Saint-Venant equations.
The main target is the development of a graphical interface that allows the users to exploit the computation without resort to a direct use of the underlying numerical scheme.
The first part briefly introduces the physical framework and presents a finite volume kinetic scheme to compute approximate solutions to the Saint-Venant system with a geometrical source term, which satisfies some fundamental properties (positivity of the water height, preservation of the steady states, entropy inequality). The parameters of the experimental setting are given, as derived from experimental studies realized at the Institut de Mécanique des Fluides in Toulouse, France.
The second part of the report is devoted to a detailed description of the software, including the instructions for installation, system requirements and hardware architecture, and a step-by-step illustration for optimal running.
It is worthwhile observing that the development of new informatics facilities causes numerical software to become rapidly obsolete, although the one presented in this report has been built using tools whose improvements are supposed to remain coherent with the previous versions.
The numerical codes are freely available upon request to the authors, by corresponding to Chiara Simeoni, Laboratoire de Mathématiques J.A. Dieudonné, Université Nice Sophia Antipolis, Parc Valrose - 06108 Nice Cedex 02, France -- simeoni@unice.fr

First part

1.1 The Saint-Venant equations

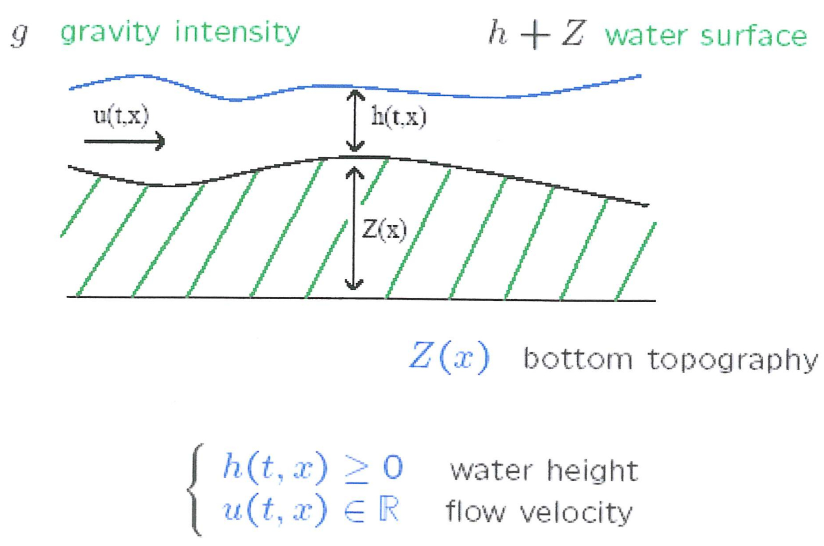
The Saint-Venant equations describe the one-dimensional flow in a rectangular channel via the height of water **h (t, x) ≥0** and its mean velocity **u (t, x) ЄR,** which check the hyperbolic system:

$$\frac{\partial h}{\partial t} + \frac{\partial}{\partial x}(hu) = 0, \qquad t \geq 0, x \in R \qquad \textbf{(1)}$$

(1) laws of conservation of the mass or continuity.

$$\frac{\partial (hu)}{\partial t} + \frac{\partial}{\partial x}\left(hu^2 + \frac{g}{2}h^2 \right) + ghZ' = 0 \qquad \textbf{(2)}$$

With g the gravitation and Z(x) the longitudinal profile of the channel's bottom. Therefore h+Z is the dimension of the free face and hu the momentum. Considering a variable topography introduces a source term in the equation **(2)** on the momentum, which intervenes in the definition of the stationary states.



By analogy with the compressible equations of Euler of the dynamics of gases, one can establish a mathematical bond between the equations of the mechanics of the fluids and the microscopic description of the associated system of particles.

Let $\chi(w), \chi(w) \in R$, be a real function

$$\chi(w) = \chi(-w), \int_R \chi(w)dw = 1, \int_R w^2 \chi(w)dw = \frac{g}{2}$$

The density of particles is defined as

$$f(t, x, \xi) = \sqrt{h(t, x)}\,\chi\left(\frac{\xi - u(t, x)}{\sqrt{h(t, x)}}\right)$$

So that it satisfies the relations

$$h = \int_R f(t, x, \xi)d\xi, \ hu = \int_R \xi f(t, x, \xi)d\xi,$$

$$hu^2 + \frac{g}{2}h^2 = \int_R \xi^2 f(t, x, \xi)d\xi,$$

The kinetic representation of the Saint-Venant equations reads

$$\frac{\partial f}{\partial t} + \xi\frac{\partial f}{\partial x} - gZ'\frac{\partial f}{\partial \xi} = 0$$

The source terms are discretized according to the Upwind Interface Source method

$$f_i^{n+1}(\xi) - f_i^n(\xi) + \frac{\Delta t}{\Delta x_i}\xi\left(f_{i+\frac{1}{2}}^{n,-}(\xi) - f_{i-\frac{1}{2}}^{n,+}(\xi)\right) = 0$$

for the discrete density $f_i^n(\xi) = \sqrt{h_i^n}\,\chi\left(\frac{\xi - u_i^n}{\sqrt{h_i^n}}\right)$

$$U_i^n = \left(h_i^n, (hu)_i^n\right),$$

$$h_i^n = \int_R f_i^n(\xi)\,d\xi \qquad (hu)_i^n = \int_R \xi f_i^n(\xi)\,d\xi$$

1.2 Kinetic Schemes for the Saint-Venant equations

To construct (finite volume) Kinetic Schemes for the Saint-Venant equations

$$U_i^{n+1} - U_i^n + \frac{\Delta t}{\Delta x_i}\left(F^{n,-}_{i+\frac{1}{2}} - F^{n,+}_{i-\frac{1}{2}} \right) = 0$$

$$F^{n,-}_{i+\frac{1}{2}} = \int_R \xi \begin{pmatrix} 1 \\ \xi \end{pmatrix} f^{n,-}_{i+\frac{1}{2}}(\xi)\, d\xi$$

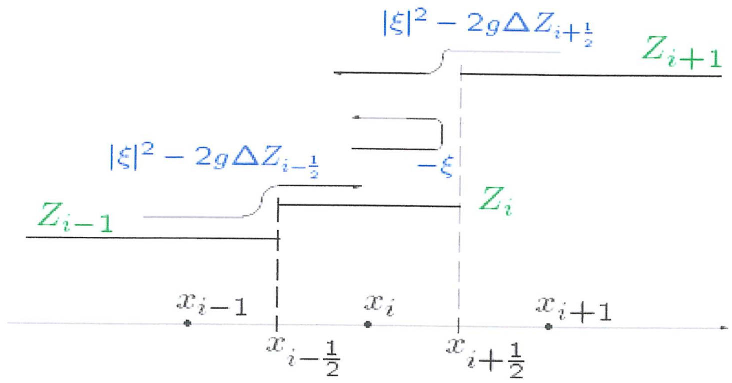
$$F^{n,+}_{i-\frac{1}{2}} = \int_R \xi \begin{pmatrix} 1 \\ \xi \end{pmatrix} f^{n,+}_{i-\frac{1}{2}}(\xi)\, d\xi$$

The kinetic fluxes are defined by means of the Method of Characteristics
The kinetic scheme with reflections reads

$$f^{n,-}_{i+\frac{1}{2}}(\xi) = f_i^n(\xi)\mathbb{1}_{\xi\geq 0} + \Big(f_i^n(-\xi)\mathbb{1}_{|\xi|^2 \leq 2g\Delta Z_{i+\frac{1}{2}}}$$
$$+ f^n_{i+1}\left(-\sqrt{|\xi|^2 - 2g\Delta Z_{i+\frac{1}{2}}}\right)\mathbb{1}_{|\xi|^2 \geq 2g\Delta Z_{i+\frac{1}{2}}}\Big)\mathbb{1}_{\xi\leq 0}$$

$$f^{n,+}_{i-\frac{1}{2}}(\xi) = f_i^n(\xi)\mathbb{1}_{\xi\leq 0} + \Big(f_i^n(-\xi)\mathbb{1}_{|\xi|^2 \leq 2g\Delta Z_{i-\frac{1}{2}}}$$
$$+ f^n_{i-1}\left(\sqrt{|\xi|^2 - 2g\Delta Z_{i-\frac{1}{2}}}\right)\mathbb{1}_{|\xi|^2 \geq 2g\Delta Z_{i-\frac{1}{2}}}\Big)\mathbb{1}_{\xi\geq 0}$$

with $\Delta Z_{i\pm\frac{1}{2}} = Z_{i\pm1} - Z_i$



Checked the condition of CFL is supposed

$$\Delta t \max_{i\in Z}\left(\left|u_i^n\right| + \sqrt{2gh_i^n}\right) \le \Delta x$$

Then, the kinetic diagram "with reflexions"

(i) is conservative for the equation on the height of water

$$F^{h,-}_{i+\frac{1}{2}} = F^{h,+}_{i+\frac{1}{2}} \quad \forall i \in Z$$

and, in general, for the homogeneous system $(Z' = 0)$

(ii) Preserve the positivity height of water, i.e.

$$h_i^n \ge 0, \quad \forall n \in N, i \in Z$$

(iii) Check an inequality of discrete entropy,

$$E_i^{n+1} + E_i^n + \frac{\Delta t}{\Delta x_i}\left(\eta^n_{i+\frac{1}{2}} - \eta^n_{i-\frac{1}{2}}\right) \le 0$$

with the discrete energy defined by

$$E_i^n = h_i^n \frac{\left|u_i^n\right|^2}{2} + \frac{g}{2}(h_i^n)^2 + gZ_i h_i^n$$

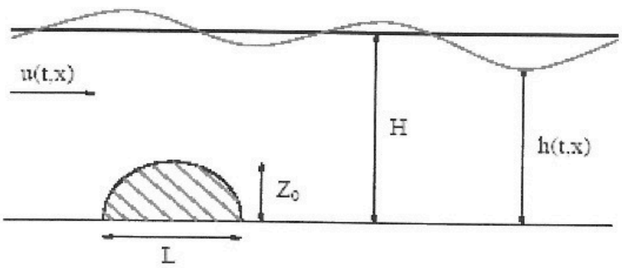
and associated flows of entropy;

(iv) preserve the stationary states of a "lake at rest»

$$u_i^n = 0, \; h_i^n + Z_i = H, \; \forall n \in \mathrm{N}, \, i \in \mathrm{Z}$$

1.3 The experimental framework

The experimental framework at the **Institut de Mécanique des Fluides in Toulouse, France.**



. Froude number $F = \frac{U}{\sqrt{gH}} \leq 1$

. Blocking factor $\alpha = \frac{Z_0}{H}$ $0.147 \leq \alpha \leq 0.7$

. Obstacle ratio $\beta = \frac{Z_0}{L}$

. Reynolds number $\mathrm{Re} = \frac{HU}{\mu}$

You find results or parameters which have been studied in laboratory :

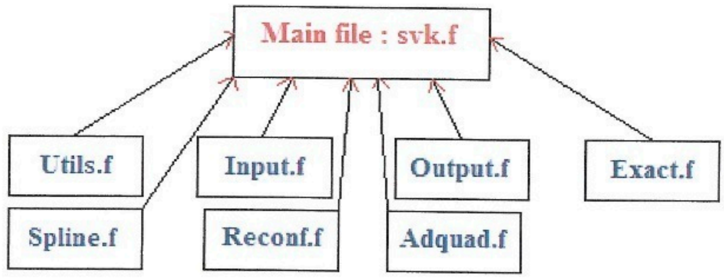
F	Z_0	α	β	Re
0.62	$1.7cm$	0.179	0.58	$2.37 * 10^4$
0.66	$1.7cm$	0.26	0.58	$1.51 * 10^4$
0.64	$4.1cm$	0.68	0.58	$1.32 * 10^4$

Second part

This software is composed of two parts.

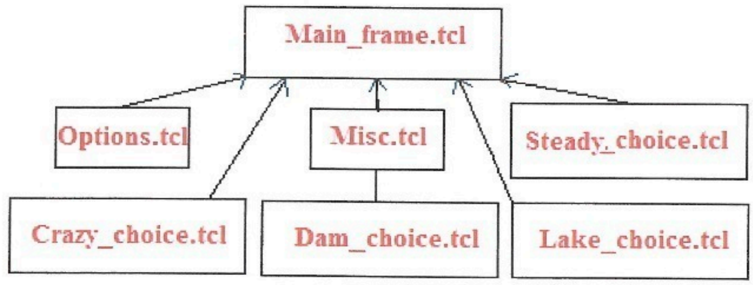
2.1 Implementation part

This part calculate the numerical solution of the equation of Saint-Venant, it is coded in FORTRAN.



2.2 Graphic part

This part allows the user to put data necessary for the calculations.



HANDBOOK

Contacts and Informations

Graphics Programmer :

Hassan BELGHAZI
belghazi@essi.fr

Alexis CUGLIETTA
cugliett@essi.fr

Emilien DESSALLES
dessalle@essi.fr

Fabien MARRONE
fabien.marrone@eisti.fr

Imade MERZOUG
merzoug@essi.fr

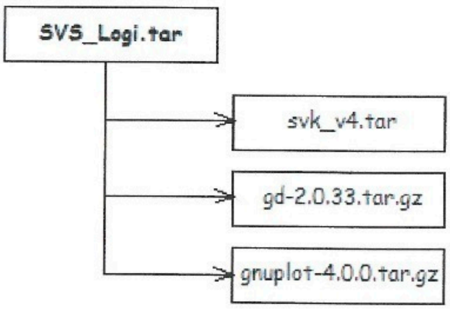
Source Code :

Chiara SIMEONI
simeoni@math.unice.fr

Licensing Agreement

The present software is free for use.
This report contains a version fully commented to allow a better reading of the files. We advise only experienced readers to undertake modifications of the codes.
All remarks and suggestions for the improvement of this software are highly welcomed.

Component of the pack



Structure of the SVS_Logi.tar file

When you got this software, you obtained the following file: **SVS_Logi.tar**. In this file, you will find three other files: one concerning the software, named **svk_v4.tar**, another concerning the graphics library associated **gd-2.0.33.tar.gz** and finally a last one concerning the very last version with **gnuplot-4.0.0.tar.gz**.

The softwares that we communicate you inside the pack are free softwares of GNU: there is no specific licence you must have. It isn't a question neither of hacking nor of illegal remote loading of information.

You will be able to find all the details besides on the following Web pages:

http://www.boutell.com/gd/ (graphics library download)
http://www.gnuplot.info/ (gnuplot download)

Installation

Required System and Components

To ensure a correct operation of the software, check before using it that you have the following configuration. In fact, this is a check about software required and not about your operating system performance. Nevertheless, you need memory to try some tests and run the program in the best conditions.

To run this program you need the following components:

About Computer:

- **Minimum Disk Space: 2 Mo** (It represents a space for installation. You need more space disk for plots, movies and installation of library and gnuplot) (**4 Mo recommended**).

- **Minimal Read-Write Memory: 32 MB (64 Mo recommended**).

- **Operating System: UNIX System (recommended) or associated**

About Software:

- **Fortran compiler** (Intel's compiler or F77 recommanded for using the main program)

- **TCL/TK v8** (recommended using the GUI)

- **Gnuplot 3.7.2 or 4** (recommended to plot the computed data files and to make movies)

In the following lines we will consider "**iff**" as the name of the FORTRAN compiler.
If you do not use this compiler, feel free to change it. In fact, with the new version of this program, it's possible to use a makefile that the package owns.

This program has been run with sucess on the following systems:

- **Debian Sarge i386** with Intel's compiler and tcl/tk 8.4
- **Mac OS 10.3** (powerbook G4)

It is necessary to have version 4 of gnuplot if you wish to make animations of the various cases you want to treat. In particular, it is necessary for you to control that it's contained if possible in the repertory called: /usr/local/bin/gnuplot. If it is not the case, it is not a serious problem: you will have simply to renew the path in Graphics Options (menu in the main frame of the program). Nevertheless, if you don't have this version you won't be able completely to build graphs. If you follow these instructions, you will obtain an optimal performance of the software and its orders. The software is contained in the associated repertory with "SVS Logi" in its tar form: **gnuplot-4.0.0.tar.gz**.

Moreover it is necessary to have a suitable library for the construction of GIF pictures. The library of the repertory of "SVS Logi" called **gd-2.0.33.tar.gz** is made with this intention. It should be installed before gnuplot: It is necessary to compile again your version of gnuplot to make it able to take into account the new bookshop.

Installation Steps

The processing installation is very simple. The only thing you have to do is to open a terminal and write in it the following lines:

1. $ **tar xvf SVS_Logi.tar** (untar the SVS package)

2. $ **cd SVS_Logi** (enter the main directory of the program)

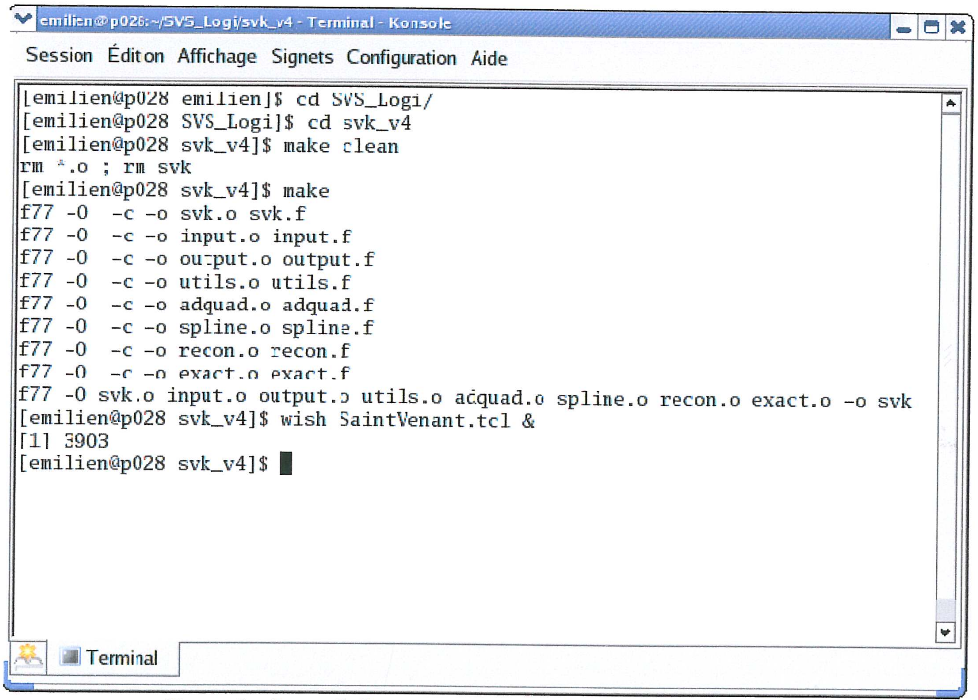
3. $ **tar xvf svk_v4.tar** (untar the SVK package)

4. $ **cd svk_v4** (enter the directory of the program)

5. $ **iff *.f** (Compile the FORTRAN source files) or **make**

6. $ **wish SaintVenant.tcl** (run the GUI)

These operations of installation are summarized in this picture of a terminal (for commodity the first step isn't present in this picture)



Description of the procedure to install the software

We advise you not to touch the files you could find in the repertory svk_v4: They are necessary for the operation of the software. An error in a file could prevent good execution of the program.

Moreover, if a new version of the software will be created, a new package will be develloped: so delete the directory svk_v4 in this case.

In the event of unspecified problem, do not hesitate to reconpile the program (order make) and to execute again the procedure of installation previously described. In the event of specific problems or if the previous answer is not enough, we incite you to defer to the FAQ at the end of this handbook.

Description

SVS Logi is more than software like the other modeler programs. With specifications given by real tests and experimentations made by scientists in a laboratory, we controlled the result of the program.

Dam – Break

Thanks to the software SVS Logi it will be possible for you to see the evolution of the level and river in cases close to reality. However they represent a mathematical model of the equations of Saint-Venant. You will be able to give by yourself an account of these phenomena in a dam-break (its role of maintenance of water to the upstream is not more assured). Thus water flows in the downstream part of the dam-break.

Lake at rest

Moreover, it is interesting to see the evolution of a lake at rest in which the bottom has geometrical and mathematical properties very characteristic of the aquatic environments and modelled in laboratories such as those we based ourselves to make the majority of our experiments.

Steady Cases

Traditional cases which arise naturally and whose majority of the scientists use for experimental data.

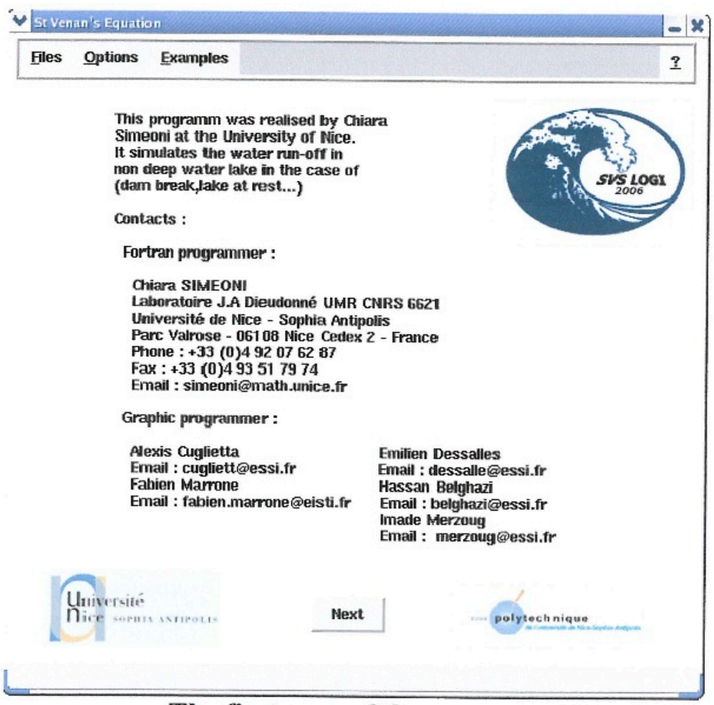
- Crazy Cases

Cases much more specific and which call upon a use much more extreme, to the limits of the capacities of the software. Indeed, it is a kind of heading test in which all the possible cases can appear since the man does not have the hand put on this part. It is the software which manages with its own way all the problems that it will meet in the determination of the water level, the load or the number of Froude.

Please always conform you at the request of the software when this one announces messages.

Moreover when there is a named button "Exit" use it in the place of the cross in the corner higher right of the window. That will make it possible to avoid some dysfunction in the good walk of the software and thus not to contribute to the creation of an error.

Following the order **wish SaintVenant.tcl**, the associated program SVS Logi opens:



The first page of the program

Next: This button gives access to the majority of the cases which the software approaches in its entirety. It will open the main frame page or confort administration of the software.

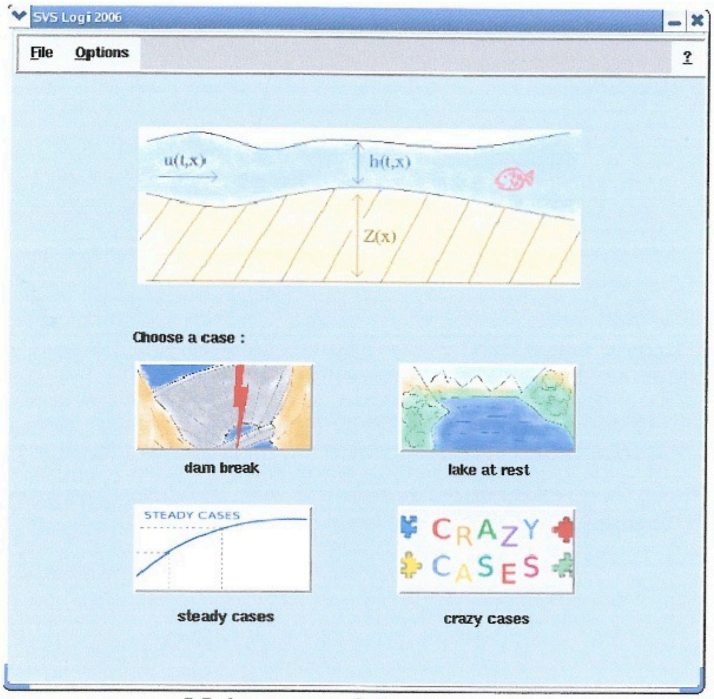
File: This menu is to use to leave the program. At this propros, we invite you to always closing the windows of the software when those propose it by the Exit button and not by the cross.

Options: This menu opens in fact small two pennies of options. It manages in fact the method use to solve the complex systems which you will subject to the software. These two small pennies are in fact : Numeric Options and Graphics

Options. All will be detailed a little further. All the information on the design of this software will be communicated to you. It will allow you to check that you have the very last version of the software. If it is not the case, refer you to the place where you got this version.

Examples: It is another way more specifically of obtaining a case without passing by the main frame page. It is acted in fact of a short cut and not of an additional option. The cases implemented and the way of using them will be set up hereafter.

When you clicked on the Next button you obtain the principal menu then:



Main menu of the program

File: This menu is to use to leave the program. In this connection, we invite you to always closing the windows of the software when those propose it to you by the Exit button and not by the cross...

Options: This menu opens two small frames of options. It manages in fact the method used to solve the complex system you will subject to the software. These two small frames are Numeric Options and Graphic Options. All will be detailed a little further.

? : All the information on the design of this software and its version will be communicated to you. It will allow you to check that you have the very last version of the software. If it isn't the case, go the web page where you will be able to obtain the last version.

Dam-break: By this button, you open the menu concerning the Dam-break.

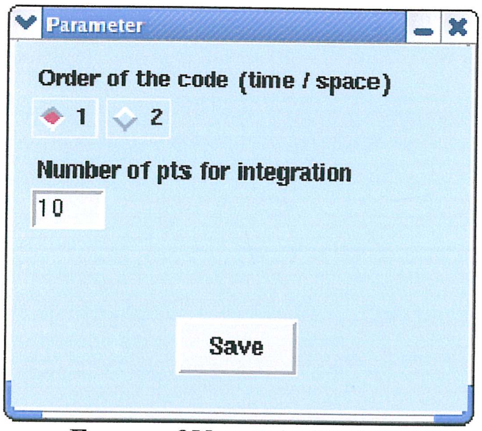
Lake At rest: By this button, you open the menu concerning the lake at rest.

Steady cases: By this button, you open the menu concerning the steady cases.

Crazy cases: By this button, you open the menu concerning the crazy cases.
We remind you that when you open this window, it will be essential to establish the Graphic Options in order to know the place exactly where is your path of gnuplot and your version in particular if it is not the current directory **(/usr/local/bin/gnuplot)**. If you would forget this data, it won't be possible to visualize the corresponding graphs or films and to use all the graphic possiblities of the software. It is a stage of initialization to do at the beginning. When a case is studied and that you return to the principal window of the program the data are preserved. Between two simulations it is always possible to modify the options. We remind you that it is highly advised to provide you with a library and an adequate version of gnuplot (refer to the paragraph concerning the installation) too.

The Options

Numeric Options



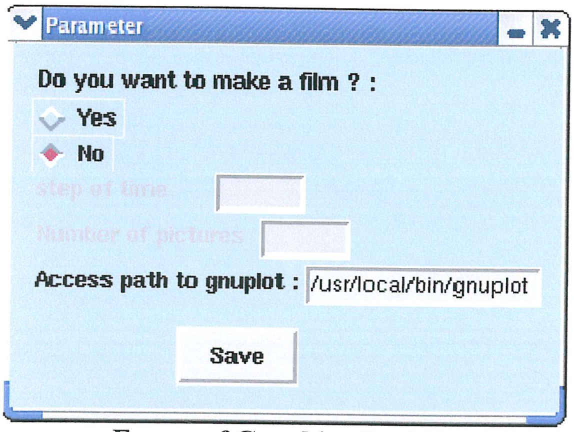
Frame of Numeric Options

By default the approximation made in the code is of the 1st order in time and in space and the number of points for integration is of 10 points.

Order in time/space: You must choose the order of the diagram on which you intend to collect information that you will develop in the experiments that you will make with this software (1st or 2nd order).

Number of points for integration: The number of points made for the calculation of the integrals is decisive in obtaining compatible results and closest to the possible exact answer.

Graphics Options



Frame of Graphics Options

Do you want to make a film? : By default the option "No" is activated. Selecting "Yes" involves the opening of the locked menu then corresponding to the parameters of film.

Step of time: You will be able to define a step of time between each pictures of animation or film which you will create.

Number of pictures: Moreover define the number of pictures which will constitute this film and the program will transmit information in the cases treated thereafter.
From now on you can also mention the way to be traversed to obtain the path gnuplot. Also, by indicating the exact place you will be able to carry out your graphs like your films.

It is advised to modify as a preliminary i.e. before trying out the software the options. In addition when you finished a simulation, it is completely possible to change its options. The principal danger would be in fact to make modifications in the course of simulation: it can't be effective simultaneously.

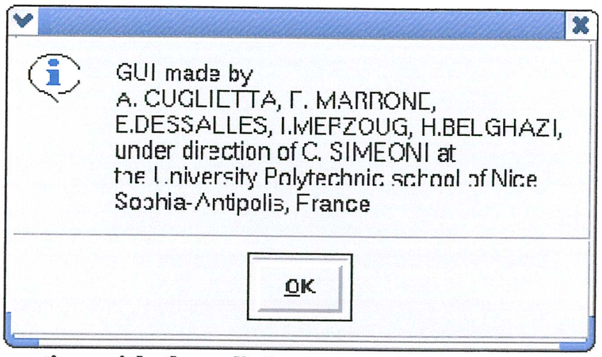
Information menu « ? »

Version

Version Box in Menu «? »

Thanks to the knowledge of this software you will see if you have the last version but also if there is a possible modification of this software. Follow the information given in the handbook so that the version of the software and the various applications as well as possible satisfy the request of all the users of SVS Logi.

By the way



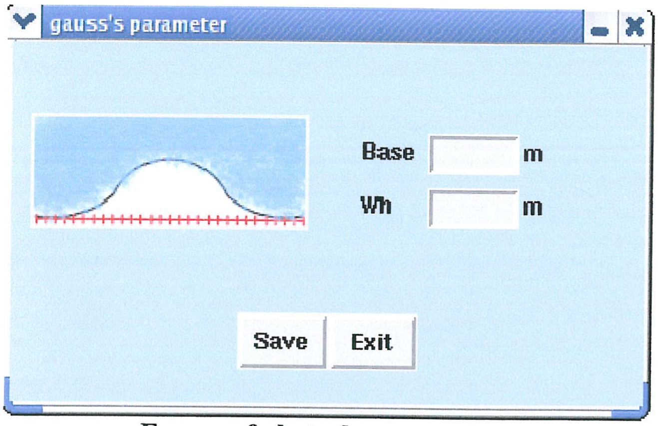
In connection with the collaborators of the SVS_Logi Project

You will find here all the people who collaborate in this project and that over various the years since the creation of the thesis by Chiara Simeoni but also by the students who contributed to the creation of the interface and the improvement of the software, i.e. code FORTRAN.

All the interest to have at disposal of such elements will be developed in a later part of this handbook. You will understand before very that they acts of the actors of this software who gave birth to SVS_Logi and which hopes well to improve it and to make it evolve/move thanks to the users.

Obstacle Menu

This will be made when after having clicked on the menu, you filled and save the data of the following window:



Frame of obstacle parameters

Base: It's one of dimensions of the obstacle which at the same time makes it possible to define it and to represent it. For a better comprehension, click on the box where it's necessary to register the position of the Base, the picture of left will move for a chart of the data to return. It will be supposed here that the obstacle doesn't overflow the whole of the points ranging between Xleft and Xright.

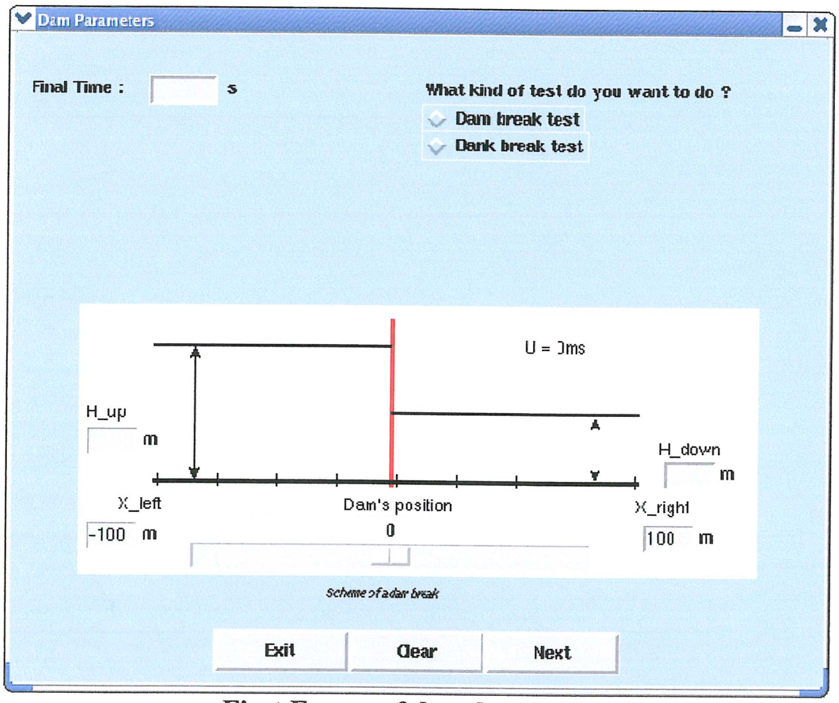
Wh: It is another dimension of the obstacle which aims at knowing the height of the obstacle. It will have in this case of the « lake at rest » to be defined to completely immerse and belongs to an underwater bottom (the precise case of an island will be tested in the crazy cases). For better comprehension, click on the case where it is necessary to register the height of the obstacle, the image of left will move for a chart of the data to return.

Thanks to this simple information it is possible to reconstruct the whole obstacle on all the channel and that for all the points which constitute it.

Dam Break

The case of the dam break is as its name indicates a dam in which exists a crack. The interest here is to see as water is worn down through the stopping, at the same time the form, its way of moving, the median altitude of water, the point of balance with in particular for a very long time the phenomenen of communicating muds.

Stage 1: Principal parameters



First Frame of dam-break case

Time: That corresponds to time you want to carry out the test.This value is expressed in secunds and is represented by a decimal number or integer but all the same positive. Moreover, that also corresponds to the time of beginning of simulation if you would wish to make a film.

Kind of test: It is just necessary to click on the button which satisfies simulation that you wish.

H_up: It is about the water level to the upstream of the stopping, i.e. the point where the level of water is most. It is a positive number.

H_down: Contrary to H_up, it is the point downstream, not low of the stopping. It will be thus lower in value than h_up. It is a positive number too.

X_left: It is about the position on the left of the stopping where one looks at the evolution of the water level in the stopping. By default, X_left is equal to -100 m. It is equal will always be necessary that it is lower than X_right.

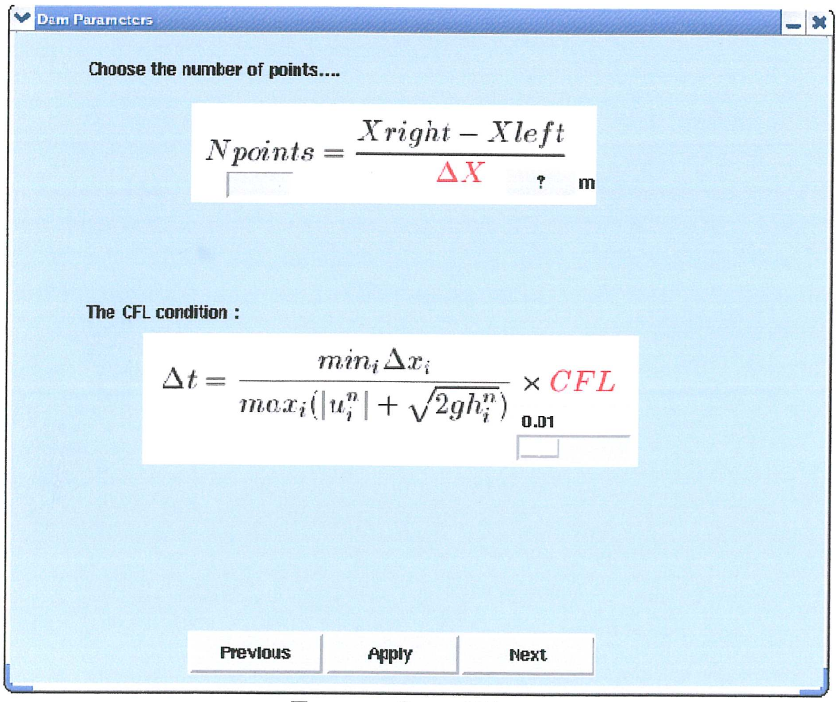
X_right: It is about the position on the right of the stopping where one looks at the evolution of the water level in the stopping. By default, X_left is equal to 100 m.

Dam's position: It is about the exact place where we put the stopping compared to X_left and X_right. Of course, we will take a value lain between the two parameters previously named.

Exit: Exit makes it possible to leave this menu to join the principal menu. All the data entered in the case of the dam-break will be lost. The data concerning the options of numerical or graphic type are however preserved.
Clear: Allows giving the default values of the window. All the data which you returned are not preserved in the continuation of the program.

Next: All the datas you communicated to the interface are preserved in the continuation of simulation and it is possible to pass following information necessary to the operation of the test.

Stage 2: A number of points and CFL



Frame of conditions

N points : It is a question of knowing in how many points the image will be cut out so that grid is of the uniform type on the whole of the stopping. It is thus about a positive number. The fact of pressing on the Apply button will calculate the variation automatically measures some between two points (step of space) of the corresponding graph.

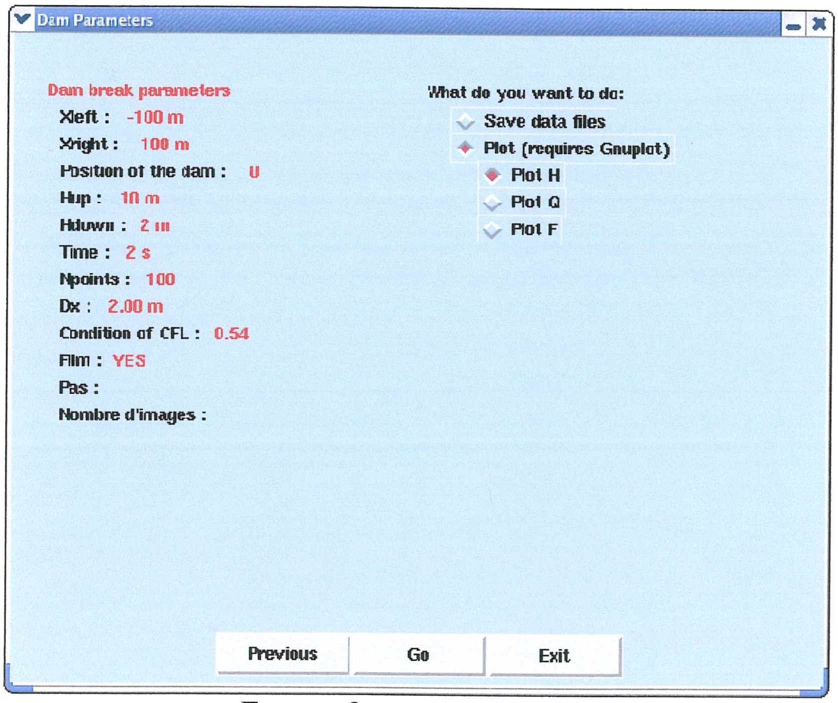
CFL: It is a question of determining the coefficient of CFL, value between 0 and 1. From this coefficient, the program will calculate the step of time associated in the resolution of the diagram.

Previous: That makes it possible to retrogress in simulation. All the preceding parameters are in preserved facts. The elements filled on the current windows i.e. that on which you clicked on the previous button are not preserved.

Apply: The Apply button calculates the step of space between two points of the graph. It is a question of an automatic calculation managed by the program.

Next: All the data which you communicated to the interface are preserved in the continuation of simulation and thus makes it possible to pass following the informtions necessary to the operation of the test.

Stage 3: Summary and layout of a graph or a film



Frame of control and action

Previous: That makes it possible to retrogress in simulation. All the preceding parameters are in preserved facts. It will be to you in fact completely possible considering the configuration of the software to change one or more parameters in simulation and to start again a test without having to leave the window.

What do you want to do? : You have the choice between keeping simulations carried out in a file or simply to post with the screen a graph or a film following the graphics options which you wished. By default, it acts of a drawing of H (height of water). If you choose to save the files which you simulate, it will be save in the repertory save_plots (**SVS_Logi/svk_v4/save_plots**). The names running are as follows: if you only choose to make graphs, the names of the data are « Htime.gif », « Ftime.gf » and « Qtime.gif ». In the case of a film, the different pictures given made up this film are numbered in the order of their appearance. Indeed, that will make it possible to easily index the logical order in which they appear with the picture.

Go: run your choice.

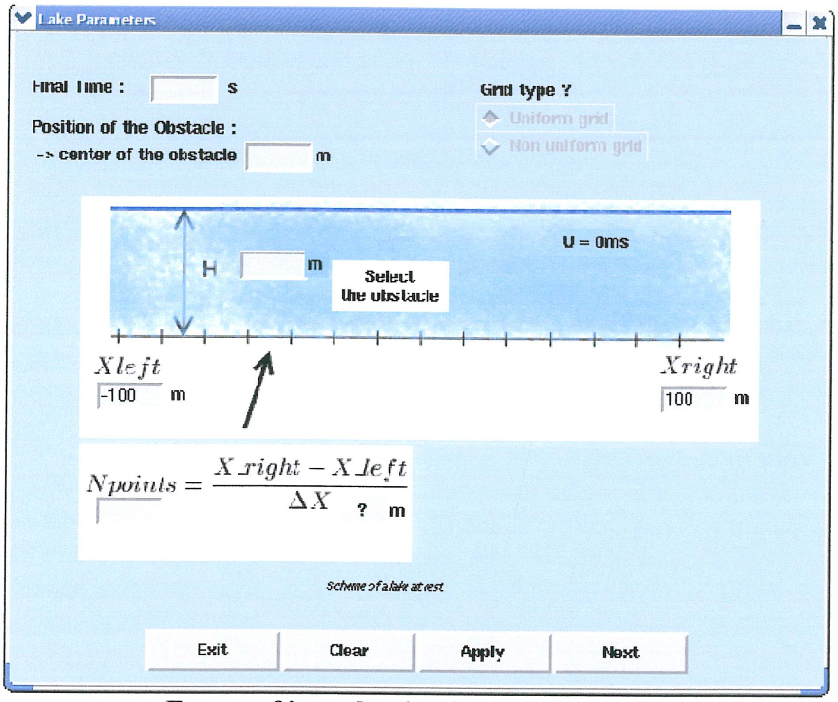
Exit: To support on exit makes it possible to leave this menu and to join the main menu. All the data entered in this case will be lost. The data concerning the options of the type numerical or graphic are however preserved.

Pay attention.If you carry out several following saves, it may be possible that you rush the preceding files. We advise you to rename data so that this kind of harmful effect doesn't occur during a forthcoming experimentation.

Lake at rest

The lake at rest is a very particular case, since it tries to prove that the type of underwater obstacle that we impose on it is naturalness .It will always remain at rest with a height of water constant and equal to that of departure.A phenomenon at the same time simplicisme by its water evolution but difficult in its mathematical realization by the Saint-Venant equations.

Stage 1: The main parameters



Frame of introduction in the lake at rest

Time: That corresponds to time you want to carry out the test.This value is expressed in seconds and is represented by a decimal number or integer but all the same positive. Moreover, that also corresponds to the time of beginning of simulation if you would wish to make a film.

H: is the water level at the beginning of simulation. It will be positive or null. Moreover, it is necessary to fill this box before filling the field concerning the height of the obstacle (we don't treat the case here islands or other standard peak iceberg...).

X_left: is the position on the left of the stopping where we look at the evolution of the water level in the stopping. By default, X_left is defect to -100 Mr. It is always necessary that it is lower than X_right.

X_right: is about the position on the right of the stopping where we look at the evolution of the water level in the stopping. By defect X_left is equal to 100 m.

Grid type? : After having chosen the type of obstacle and to have filled the corresponding data, you will be able to choose the type of grid which you want to set up on the graphs. The uniform case doesn't distinguish particular grid between the obstacle and the remainder, contrary to the nonuniform grid.

N points (in black): It is a question of knowing in how many points the picture will be cut out in a uniform grid case. It is about a positive number. The fact of pressing on the Apply button will calculate the variation automatically measures some between two points (step of space) of the corresponding graph.

N points (in red): If the nonuniform grid of the type were selected you will have the possibility of defining the number of points which define the obstacle. It is also about a positive number.
Center of the obstacle: It is a question of determining the exact place where you position the obstacle compared to the channel on which you work, between Xleft and Xright. It is a positive value which will be determined by comparison with the data of Xleft.

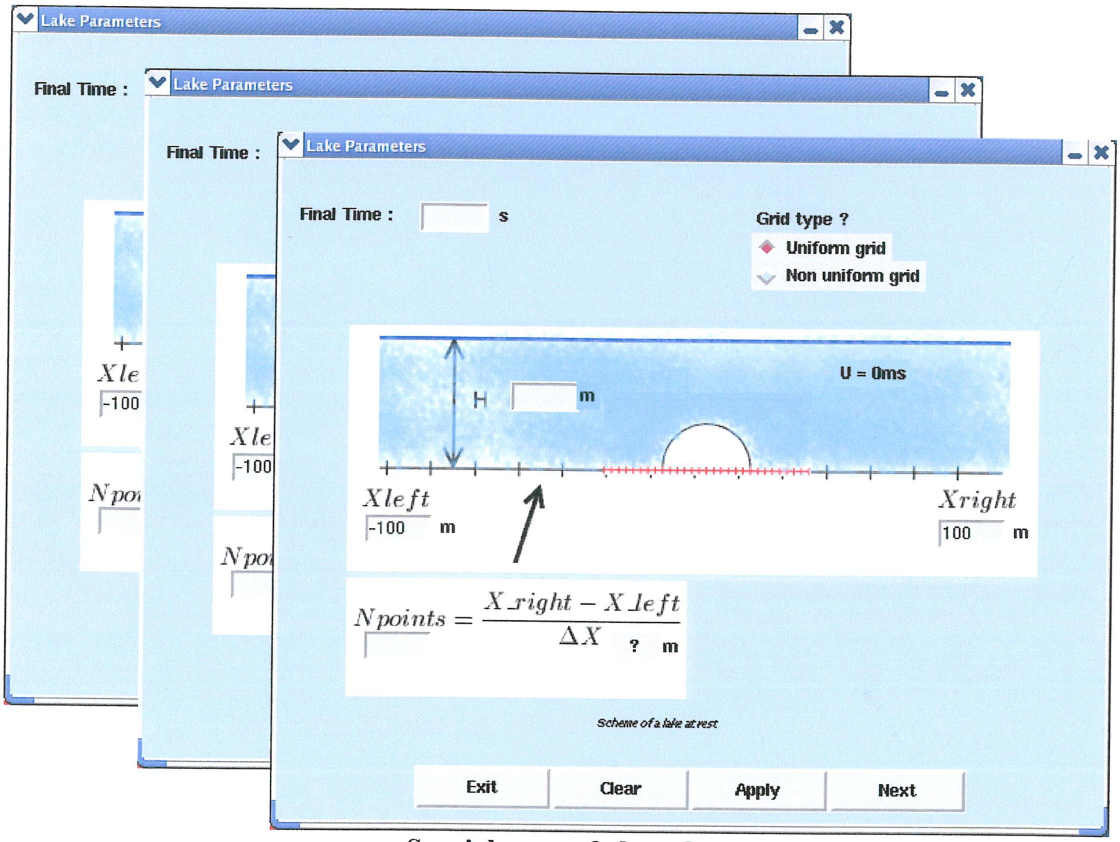
Exit: All the data you communicated to the interface are preserved in the continuation of simulation and thus makes it possible to pass following the informtions necessary to the operation of the test.

Clear: Allows to give the default values of the window. All the data which you returned are not preserved in the continuation of the program.

Apply: The Apply button calculates the step of space between two points of the graph. It is a question of an automatic calculation managed by the program.

Next: All the data you communicated to the interface are preserved in the continuation of simulation and thus makes it possible to pass following the informtions necessary to the operation of the test.

Select the obstacle: Here the unfolding which follows the fact of clicking on this window:

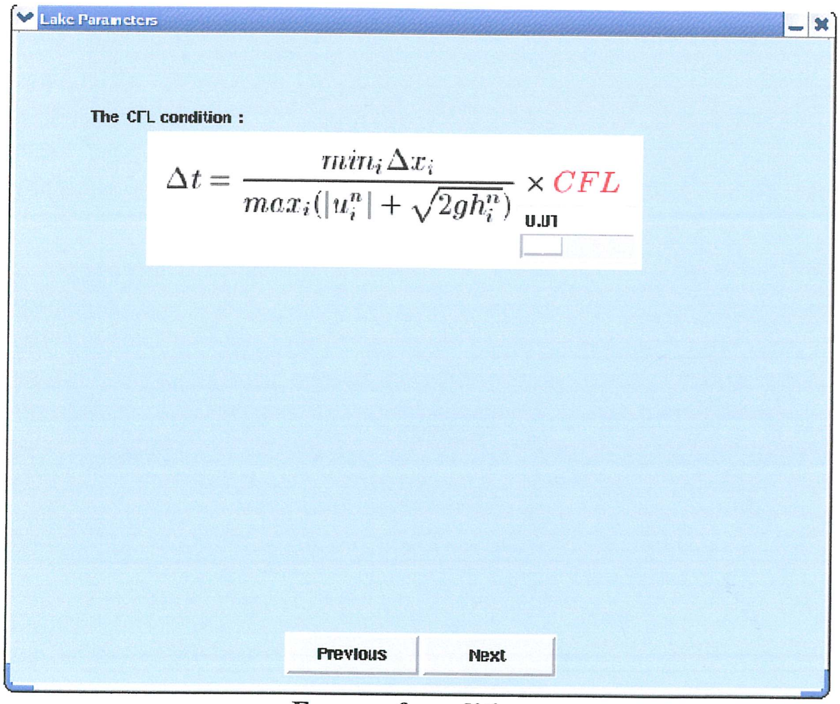


Special cases of obstacle

According to the type of obstacle that you choose "Select the obstacle" in the preceding image, you obtain one of these picturess (different drawings of the obstacle).

Moreover, after you chose a type of obstacle and returned the adequate characteristics, i.e. checking the fact in particular that the height of water is higher than the height of the obstacle (thing nonallowed but allowed here in the crazy choises), the consisting menu has to choose the type of grid you want to apply to the model. The grid chosen can be either uniform or not uniform.

Stage 2: Parametrage of the conditions



Frame of conditions

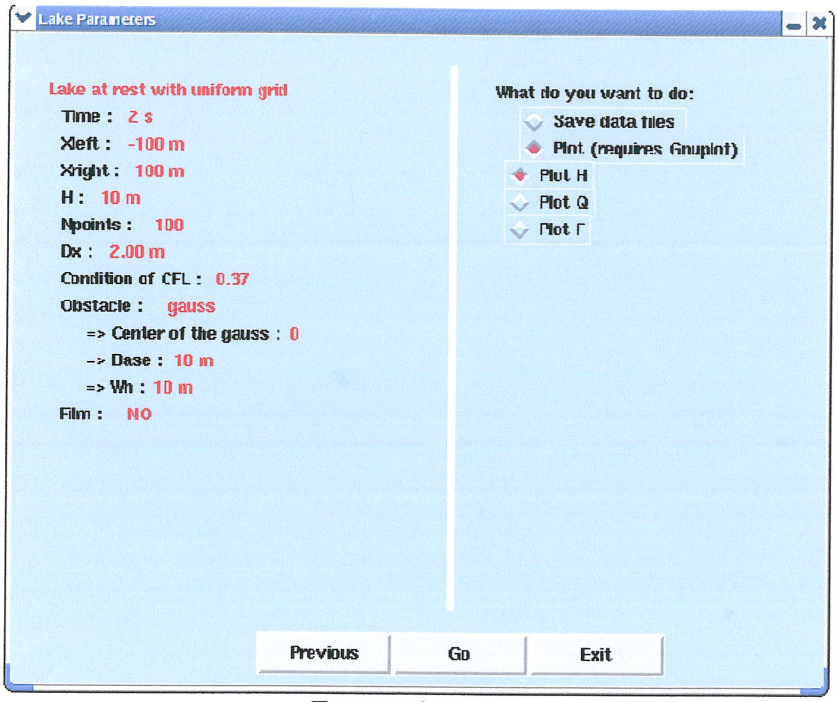
CFL: It is a question of determining the coefficient of CFL, value between 0 and 1. From this coefficient, the program will calculate the step of time associated in the resolution of the diagram.

Previous: That makes it possible to retrogress in simulation. All the preceding parameters are in preserved facts. It will be to you in fact completely possible considering the configuration of the software to change one or more parameters in simulation and to start again a test without having to leave the window.

Next: All the data you communicated to the interface are preserved in the continuation of simulation and thus makes it possible to pass following the informations necessary to the operation of the test.

In fact, it should be known according to the mathematics part which was seen previously that the only way of modelling in rather good conditions the model of the equations of Saint Venant in the case of flow of water is to make at the same time stable diagram and higher order in order to the diagram converges towards the real solution. Nevertheless, to ensure the stability of the diagram, it is necessary to check the CFL. It is thus by preoccupation of scale, grid and a stability vision that this parameter is present.

Stage 3: Control parameters and action



Frame of control

Previous: That makes it possible to retrogress in simulation. All the preceding parameters are in preserved facts. It will be completely possible for you considering the configuration of the software to change one or more parameters in simulation and to start again a test without having to leave the window.

Go: run your choice.

Exit: To support on exit makes it possible to leave this menu and to join the main menu. All the data entered in this case will be lost. The data concerning the options of the type numerical or graphic are however preserved.

What do you want to do? : You have the choice between keeping simulations carried out in a file or simply to post with the screen a graph or a film following the graphics options which you wished. By default, it acts of a drawing of H (height of water). If you choose to save the files which you simulate, it will be saving in the repertory save_plots (**SVS_Logi/svk_v4/save_plots**). The names running are as follows: if you only choose to make graphs, the names of the data are « Htime.gif », « Ftime.gf » and « Qtime.gif ».

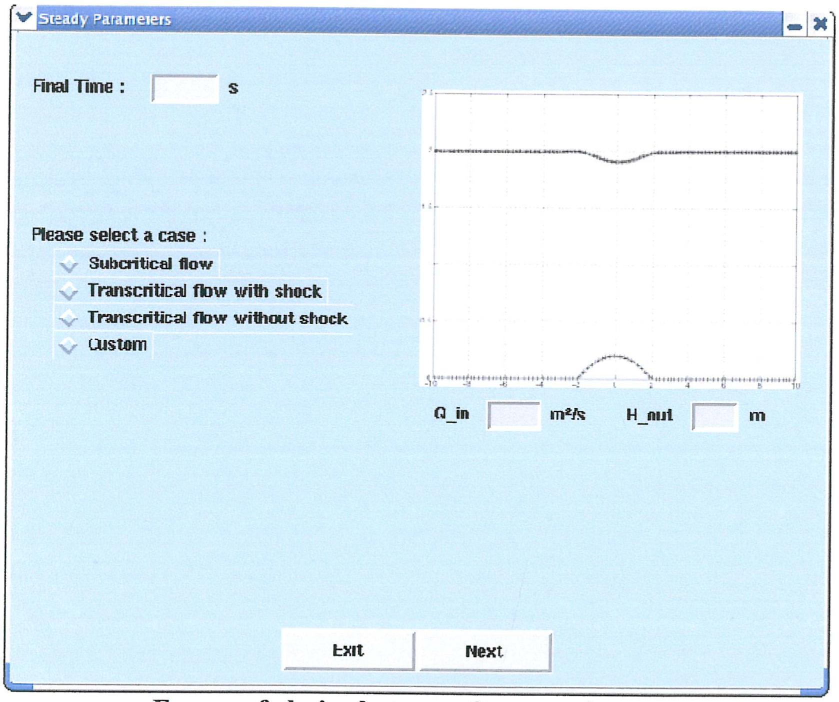
In the case of a film, the different pictures of the film are numbered in the order of their appearance. Indeed, that will make it possible to easily index the logical order in which they appear with the picture. If you chose to put in place a nonuniform grid, this stage

3 is represented by the same kind of windows. It also comprises the parameters related to this particular grid.

Steady Cases

The steady cases are very special because they represent an extreme type where the value of only one variable is exploited (the Froude number).

Stage 1: Initialisation stage and choice



Frame of choice between four steady cases

Select a case: You can choose between 4 cases: Subcritical (Fo < 1), Transcritical with shock (Fo = 1) and Transcritical without shock (Fo > 1).

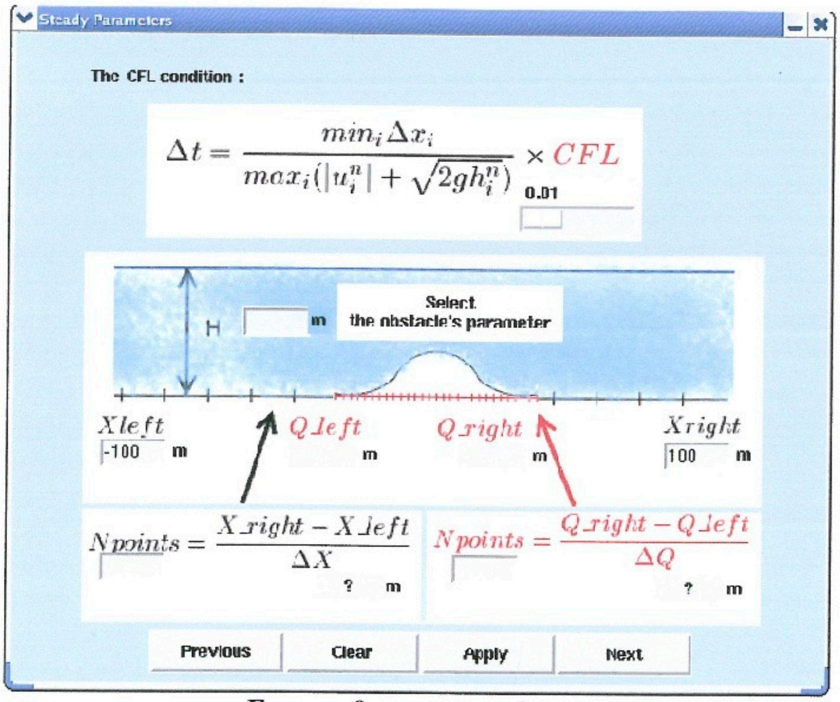
Time: That corresponds to time you want to carry out the test.This value is expressed in seconds and is represented by a decimal number or integer but all the same positive. Moreover, that also corresponds to the time of beginning of simulation if you would wish to make a film.

Exit: Exit makes it possible to leave this menu and to join the principal menu. All the data entered in the case of the dam-break will be lost. The data concerning the options of numerical or graphic type are however preserved.

Next: All the data you communicated to the interface are preserved in the continuation of simulation and thus makes it possible to pass following the informations necessary to the operation of the test.

Q_in and Q_out are values in reading alone, i.e. values which were tested for their characteristics and which were implemented within the framework

Stage 2 : Conditions and Parameters



Frame of parameters input

CFL: It is a question of determining the coefficient of CFL, value between 0 and 1. From this coefficient, the program will calculate the step of time associated in the resolution of the diagram.

H: It is about the water level at the beginning of simulation. It will be positive or null. Moreover, it is necessary to fill this box before filling the field concerning the height of the obstacle (we don't treat the case here islands or other standard peak iceberg...).

N points (en black): It is a question of knowing in how many points the picture will be cut out. It is thus about a positive number. The fact of pressing on the Apply button will calculate the variation between two points (step of space) of the corresponding graph.

N points (in red): If the nonuniform grid of the type were selected you will have the possibility of defining the number of points which define the obstacle. It is also about a positive number.

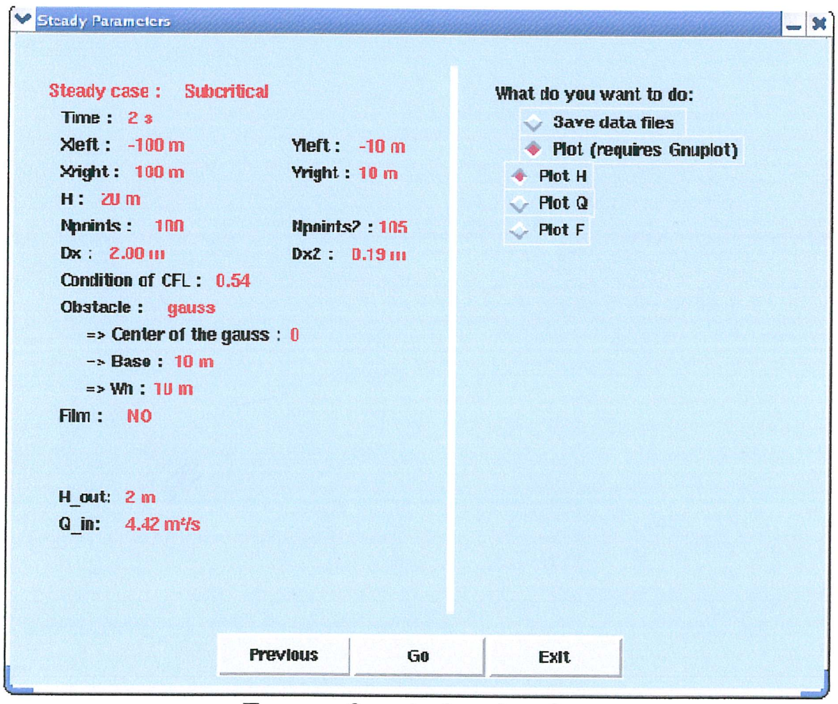
Select the obstacle's parameter: For better understanding how to fill the elements of the parameter setting of the obstacle defer to the section relating to « **Obstacle Menu** ». Nevertheless for not overloading this window, the presence of **center of the obstacle** as parameter in this new window must be understood as in the case of dam-break or lake at rest where it was apart from this new window.

Previous: That makes it possible to retrogress in simulation. All the preceding parameters are in preserved facts. It will be to you in fact completely possible considering the configuration of the software to change one or more parameters in simulation and to start again a test without having to leave the window.

Clear: Allows giving the default values of the window. All the data which you returned are not preserved in the continuation of the program.
Apply: The Apply button calculates the step of space between two points of the graph. It is a question of an automatic calculation managed by the program.

Next: All the data which you communicated to the interface are preserved in the continuation of simulation and thus makes it possible to pass following the informtions necessary to the operation of the test.

Stage 3 : Control and action



Frame of control and action

What do you want to do? : You have the choice between keeping simulations carried out in a file or simply to post with the screen a graph or a film following the graphics options which you wished. By default, it acts of a drawing of H (height of water). If you choose to save the files which you simulate, it will be saving in the repertory save_plots (**SVS_Logi/svk_v4/save_plots**). The names running are as follows: if you only choose to make graphs, the names of the data are « Htime.gif », « Ftime.gf » and « Qtime.gif ». In the case of a film, the different pictures given made up this film are numbered in the order of their appearance. Indeed, that will make it possible to easily index the logical order in which they appear with the image.

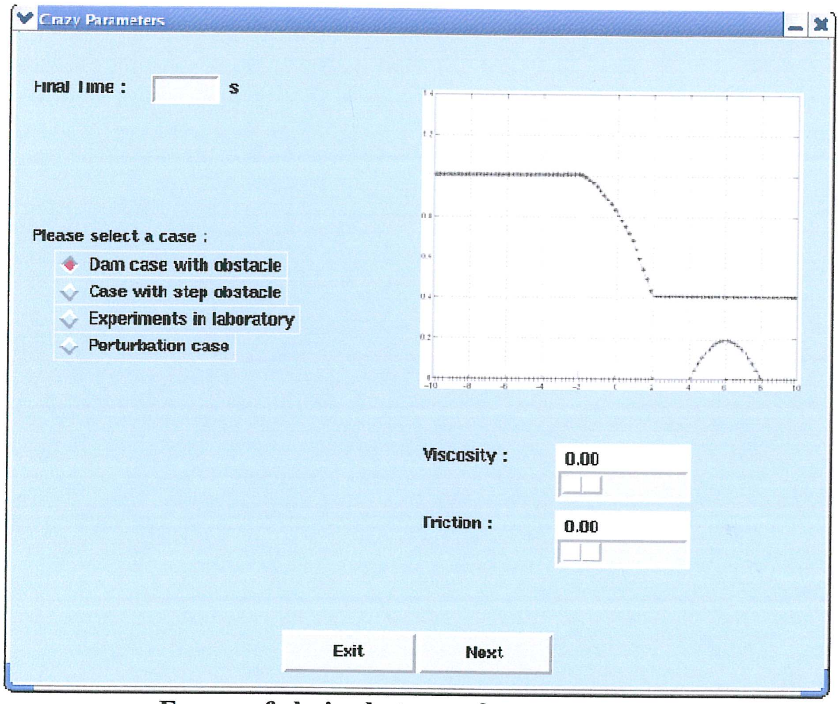
Previous: That makes it possible to retrogress in simulation. All the preceding parameters are in preserved facts. It will be to you in fact completely possible considering the configuration of the software to change one or more parameters in simulation and to start again a test without having to leave the window.

Go: run your choice.

Exit: To support on exit makes it possible to leave this menu and to join the main menu. All the data entered in this case will be lost. The data concerning the options of the type numerical or graphic are however preserved.

Crazy cases

Stage 1: Initialisation stage and choice



Frame of choice between four crazy cases

Select a case: You can choose between 4 cases of crazy cases, namely as of case in which we test according to an extension or special case that was impossible to do in another heading: one with an obstacle in a dam break case, another with a new sort of obstacle and still for exmaple, experiments realizedin a laboratory which could be a sort of comparison with reality.

Time: That corresponds to time you want to carry out the test.This value is expressed in seconds and is represented by a decimal number or integer but all the same positive. Moreover, that also corresponds to the time of beginning of simulation if you would wish to make a film.

Viscosity: In order to increase the complexity of the model and to make it thus more real, we added the case where the medium in which we are has a viscosity coefficient. It is thus a value between 0 and 1 (0 thus imply that one neglects this parameter). That causes notorious to slow down the flow since the particles slip with difficulty the ones on the others (less kinetics).

Friction: In the same way, it is possible to set up a coefficient of friction. It is thus about a parameter between 0 and 1 (0 imply that one neglects the parameter). This parameter serves to visualize the effect of acceleration or deceleration as the particles with respect to the bottom which one chose.

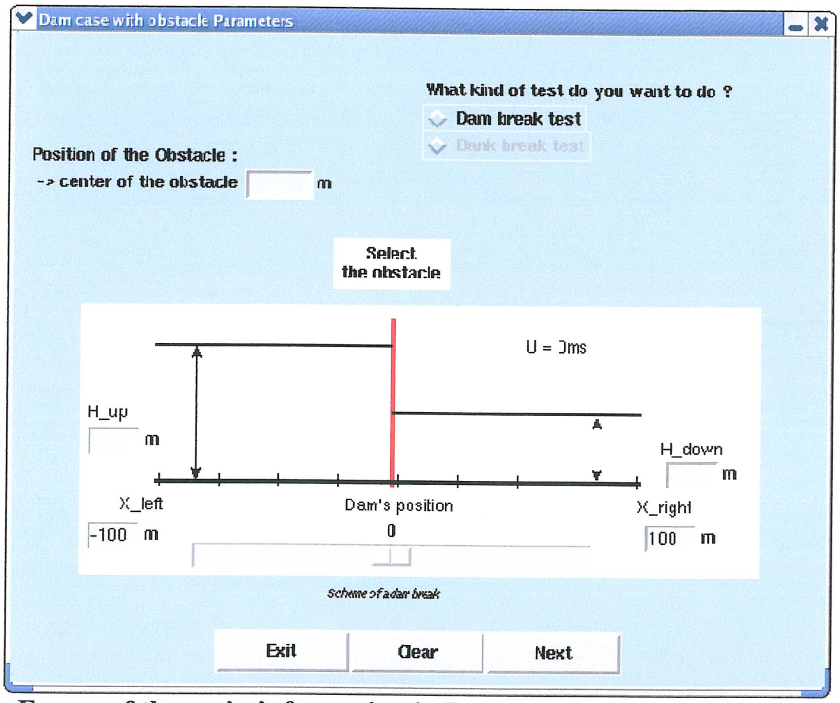
Exit: Exit makes it possible to leave this menu is to join the principal menu. All the data entered the case of the dam-break will be lost. The data concerning the options of numerical or graphic type are however preserved.

Next: All the data which you communicated to the interface are preserved in the continuation of simulation and thus makes it possible to pass following the informations necessary to the operation of the test.

1. Dam Case with obstacle

It is a real case but also experimental because he aims at showing the brake which a considerable element in a case exerts where the water push is very significant thus a strong inertia.

Stage 2 : Principal parameters



Frame of the main information in Dam break with obstacle case

Time: That corresponds to time you want to carry out the test.This value is expressed in seconds and is represented by a decimal number or integer but all the same positive. Moreover, that also corresponds to the time of beginning of simulation if you would wish to make a film.

Kind of test: It is just necessary to click on the button which satisfies simulation that you wish.

H_up: It is about the water level to the upstream of the stopping, i.e. the point where the level of water is most. It is a positive number.

H_down: Contrary to H_up, it is here about the point downstream, not low of the stopping. It will be thus lower in value than h_up. It is a positive number too.

X_left: It is about the position on the left of the stopping where one looks at the evolution of the water level in the stopping. By default, X_left is equal to -100 m. It is equal will always be necessary that it is lower than X_right.

X_right: It is about the position on the right of the stopping where one looks at the evolution of the water level in the stopping. By default, X_left is equal to 100 m.

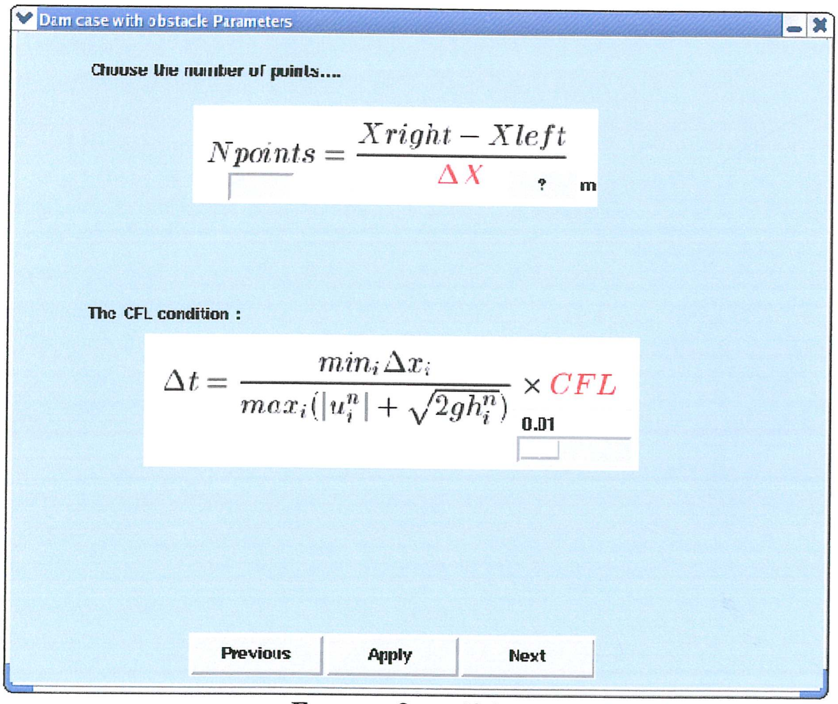
Dam's position: It is about the exact place where we put the stopping compared to X_left and X_right. Of course, we will take a value lain between the two parameters previously named.

Center of the obstacle: It is a question of determining the exact place where you put the obstacle compared to the channel on which you work, between Xleft and Xright. It is a positive value which will be determined by comparison with the data of Xleft.
Exit: Exit makes it possible to leave this menu and to join the principal menu. All the data entered the case of the dam-break will be lost. The data concerning the options of numerical or graphic type are however preserved.

Clear: Allows to give the default values of the window. All the data which you returned are not preserved in the continuation of the program.

Next: All the data which you communicated to the interface are preserved in the continuation of simulation and thus makes it possible to pass following information necessary to the operation of the test.

Stage 2: A number of points and CFL



Frame of conditions

N points: It is a question of knowing in how many points the picture will be cut out. It is thus about a positive number. The fact of pressing on the Apply button will calculate the variation automatically measures some between two points (step of space) of the corresponding graph.

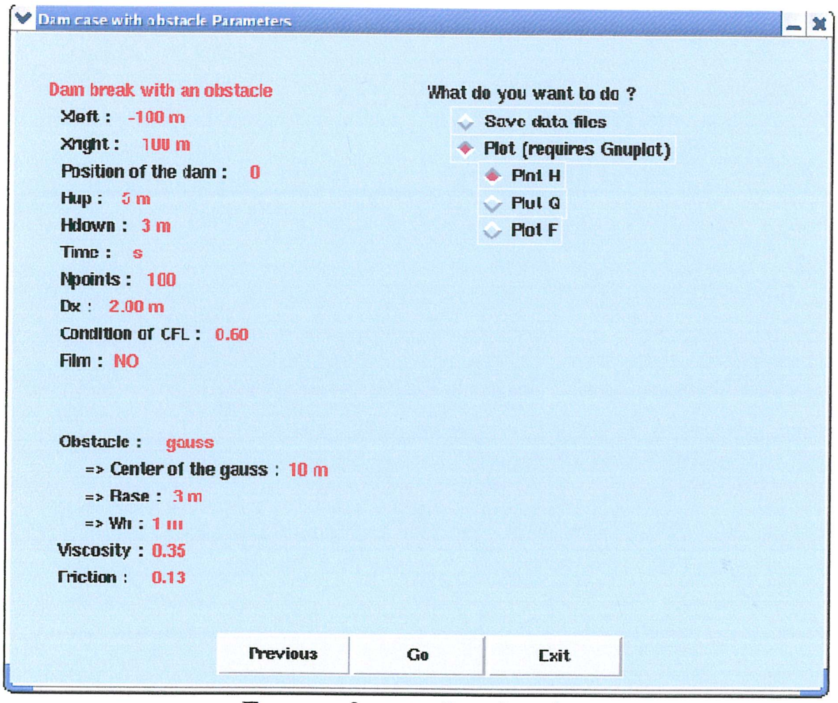
CFL: It is a question of determining the coefficient of CFL, value between 0 and 1. From this coefficient, the program will calculate the step of time associated in the resolution of the diagram.

Previous: That makes it possible to retrogress in simulation. All the preceding parameters are in preserved facts. The elements filled on the current windows i.e. that on which you clicked on the previous button are not preserved.

Apply: The Apply button calculates the step of space between two points of the graph. It is a question of an automatic calculation managed by the program.

Next: All the data you communicated to the interface are preserved in the continuation of simulation and thus makes it possible to pass following the informtions necessary to the operation of the test.

Stage 3: Summary and layout of a graph or a film



Frame of control and action

Previous: That makes it possible to retrogress in simulation. All the preceding parameters are in preserved facts. It will be completely possible for you considering the configuration of the software to change one or more parameters in simulation and to start again a test without having to leave the window.

What do you want to do? : You have the choice between keeping simulations carried out in a file or simply to post with the screen a graph or a film following the graphics options you wished. By default, it is a drawing of H (height of water). If you choose to save the files you simulate, it will be saved in the repertory save_plots (**SVS_Logi/svk_v4/save_plots**). The names running are as follows: if you only choose to make graphs, the names of the data are « Htime.gif », « Ftime.gf » and « Qtime.gif ». In the case of a film, the different pictures given made up this film are numbered in the order of their appearance. Indeed, that will make it possible to easily index the logical order in which they appear with the image.

Go: run your choice.

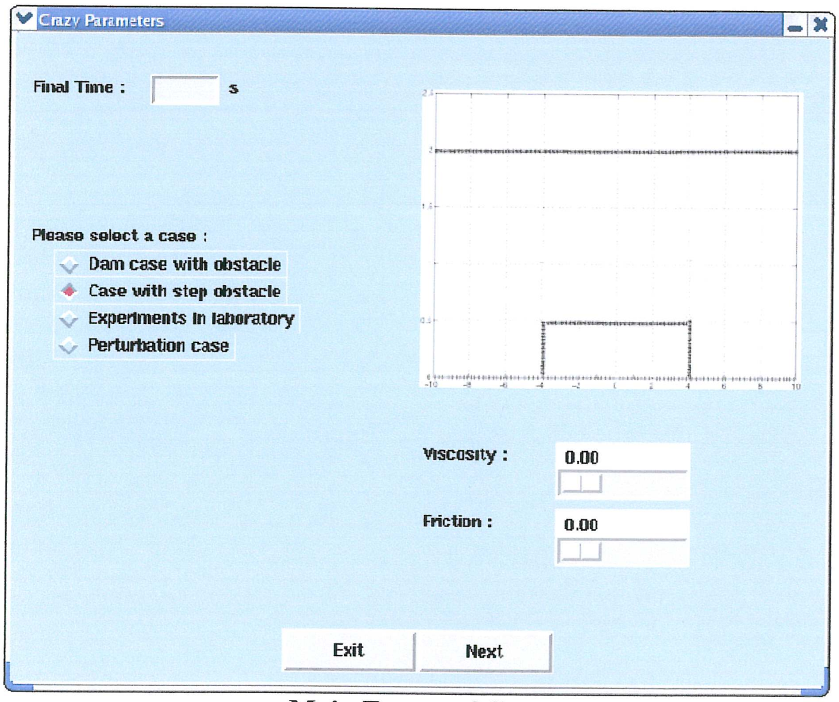
Exit: To support on exit makes it possible to leave this menu and to join the main menu. All the data entered in this case will be lost. The data concerning the options of the type numerical or graphic are however preserved.

Pay attention. If you carry out several following saves, it may be possible that you rush the preceding files. We advise you to rename data so that this kind of nuisance doesn't occur during a forthcoming experimentation.

2. Case with obstacle

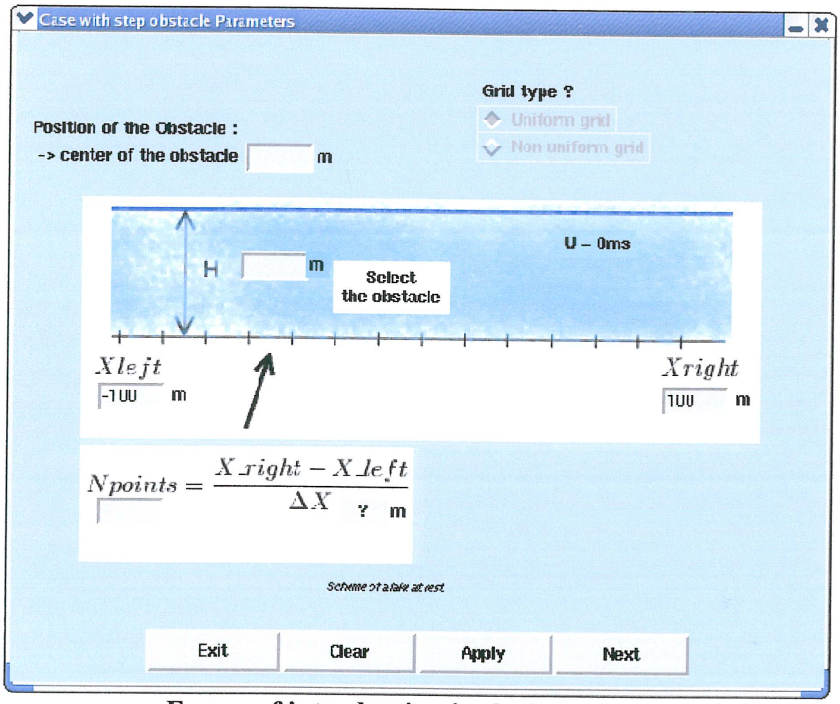
This heading calls upon the possible limits of the software in which the user has only few means of pressure. Indeed, contrary to the other studied obstacles, one can set up here a case of discontinuous obstacle, like an entry of the type walks. Doesn't the water level risk following it?

You arrive in this menu if you click on Next in the picture just after:



Main Frame of Crazy cases

Stage 1: The main parameters



Frame of introduction in the lake at rest

Time: That corresponds to time you want to carry out the test.This value is expressed in seconds and is represented by a decimal number or integer but all the same positive. Moreover, that also corresponds to the time of beginning of simulation if you would wish to make a film.

H: It is about the water level at the beginning of simulation. It will be positive or null. Moreover, it is necessary to fill this box before filling the field concerning the height of the obstacle (we don't treat the case here islands or other standard peak iceberg...).

X_left: is the position on the left of the stopping where one looks at the evolution of the water level in the stopping. By default, X_left isdefect to -100 Mr. It is equal will always be necessary that it is lower than X_right.

X_right: is the position on the right of the stopping where one looks at the evolution of the water level in the stopping. By defect X_left is equal to 100 m.

Grid type? : After having chosen the type of obstacle and to have filled the corresponding data, you will be able to choose the type of grid which you want to set up on the graphs. The uniform case doesn't distinguish particular grid between the obstacle and the remainder, contrary to the nonuniform grid.

N points (en black) : It is a question of knowing in how many points the image will be cut out so that grid is of the uniform type on the whole of the graph. It is thus about a positive number. The fact of pressing on the Apply button will calculate the variation automatically measures some between two points (step of space) of the corresponding graph.

N points (in red): If the nonuniform grid of the type were selected you will have the possibility of defining the number of points which define the obstacle. It is also about a positive number.
Center of the obstacle: It is a question of determining the exact place where you position the obstacle compared to the channel on which you work, between Xleft and Xright. It is a positive value which will be determined by comparison with the data of Xleft.

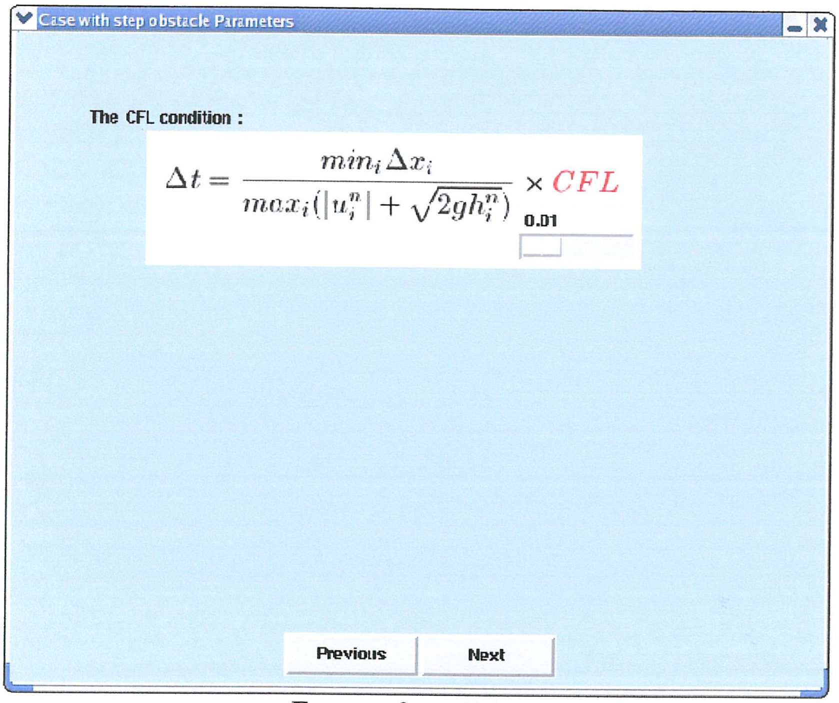
Exit: All the data which you communicated to the interface are preserved in the continuation of simulation and thus makes it possible to pass following the informtions necessary to the operation of the test.

Clear: Allows giving the default values of the window. All the data which you returned are not preserved in the continuation of the program.

Apply: The Apply button calculates the step of space between two points of the graph. It is a question of an automatic calculation managed by the program.

Next: All the data which you communicated to the interface are preserved in the continuation of simulation and thus makes it possible to pass following the informtions necessary to the operation of the test.

Stage 2: Parametrage of the conditions



Frame of conditions

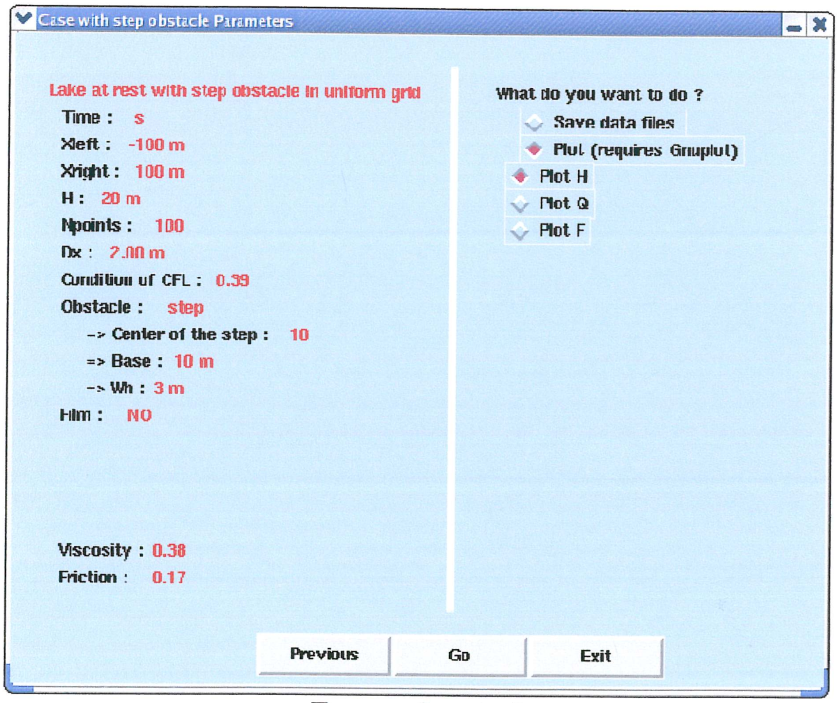
CFL: It is a question of determining the coefficient of CFL, value between 0 and 1. From this coefficient, the program will calculate the step of time associated in the resolution of the diagram.

Previous: That makes it possible to retrogress in simulation. All the preceding parameters are in preserved facts. It will be completely possible for you considering the configuration of the software to change one or more parameters in simulation and to start again a test without having to leave the window.

Next: All the data you communicated to the interface are preserved in the continuation of simulation and thus makes it possible to pass following the informations necessary to the operation of the test.

In fact, it should be known according to the mathematics part which was seen previously that the only way of modelling in rather good conditions the model of the equations of Saint Venant in the case of flow of water is to make at the same time stable diagram and higher order in order to the diagram converges towards the real solution. Nevertheless, to ensure the stability of the diagram, it is necessary to check the CFL. It is thus by preoccupation of scale, grid and a stability vision that this parameter is present.

Stage 3: Control parameters and action



Frame of control

Previous: That makes it possible to retrogress in simulation. All the preceding parameters are in preserved facts. It will be completely possible for you considering the configuration of the software to change one or more parameters in simulation and to start again a test without having to leave the window.

Go: run your choice.

Exit: To support on exit makes it possible to leave this menu and to join the main menu. All the data entered in this case will be lost. The data concerning the options of the type numerical or graphic are however preserved.

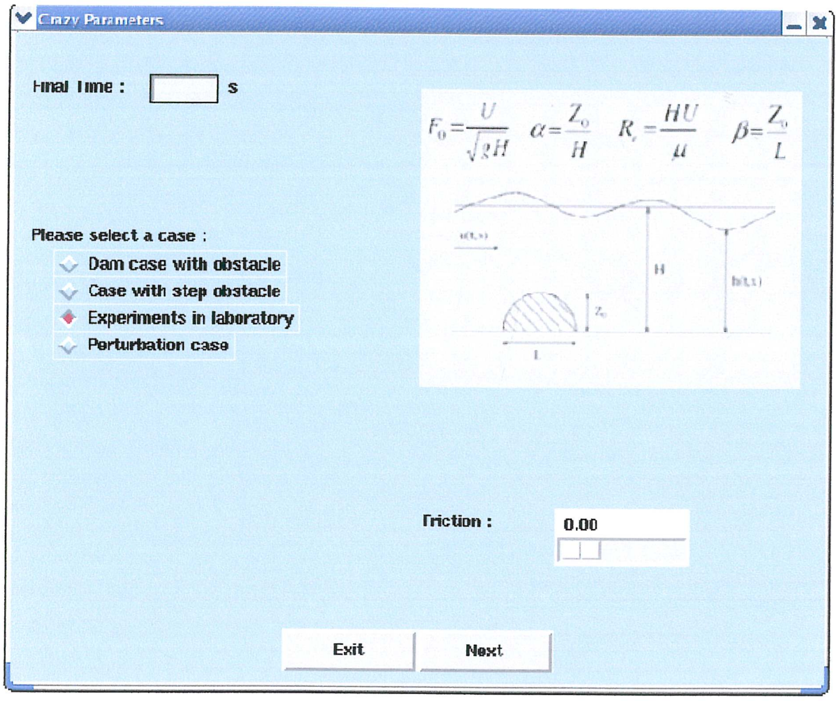
What do you want to do? : You have the choice between keeping simulations carried out in a file or simply to post with the screen a graph or a film following the graphics options which you wished. By default, it acts of a drawing of H (height of water). If you choose to save the files which you simulate, it will be saving in the repertory save_plots (**SVS_Logi/svk_v4/save_plots**). The names running are as follows: if you only choose to make graphs, the names of the data are « Htime.gif », « Ftime.gf » and « Qtime.gif ». In the case of a film, the different pictures given made up this film are numbered in the order of their appearance. Indeed, that will make it possible to easily index the logical order in which they appear with the image.

If you chose to put in place a nonuniform grid, this stage 3 is represented by the same kind of windows but it also includes parameters related to this particular grid.

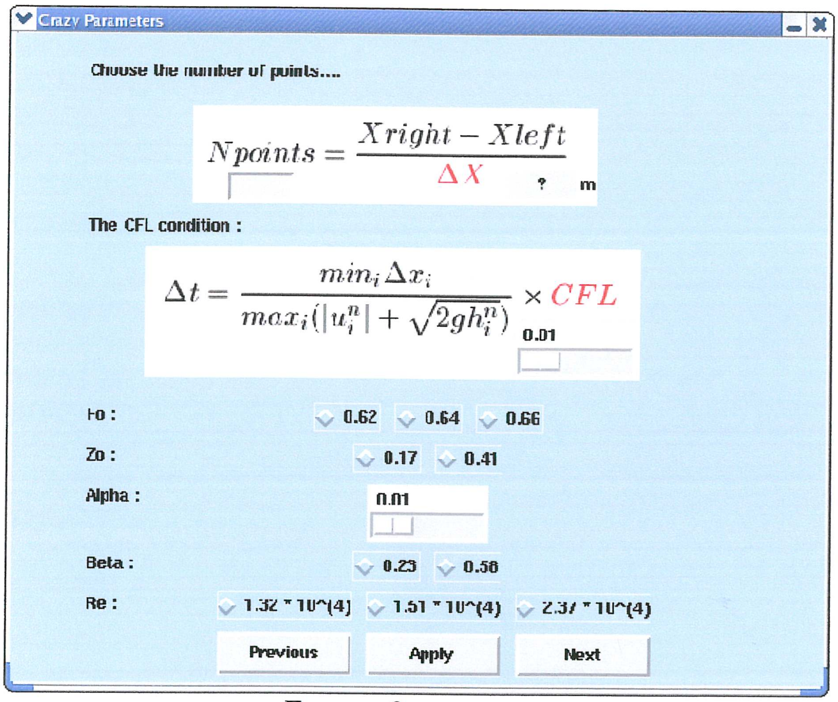
3. Experiments in laboratory

In this heading, we have made tests natural size in a laboratory with a channel. As the image shows it which illustrates this case, we will define a system with a water level an obstacle, etc. thus the same parameters as previously but in the particular case where the parameters are given starting from coefficents that you have chosen among certain values given

You arrive in this menu if you click on Next in the picture just after:



Stage 1 : Conditions and input paramaters



Frame of parameters

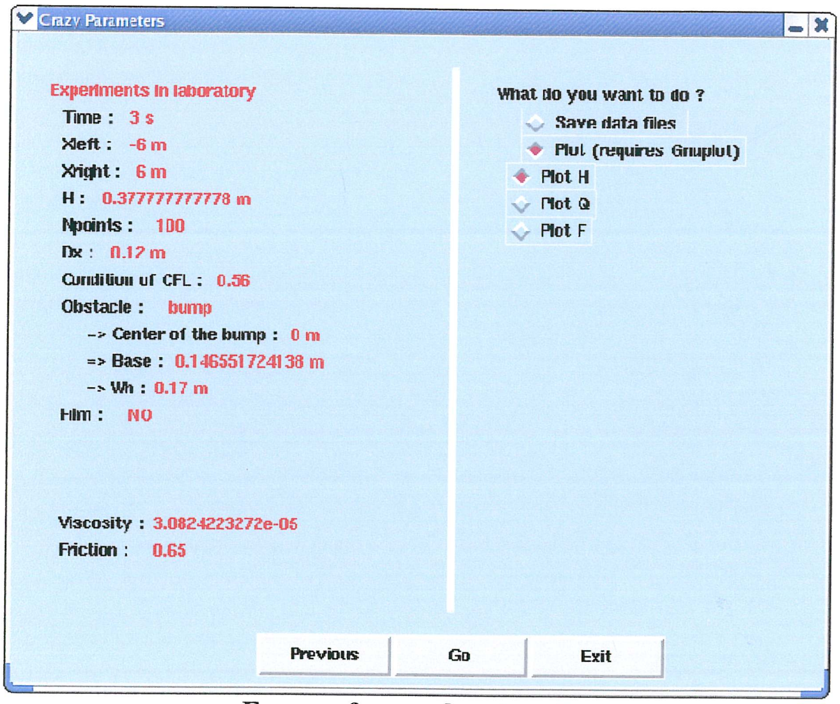
N points: It is a question of knowing in how many points the image will be cut out. It is thus about a positive number. The fact of pressing on the Apply button will calculate the variation automatically measures some between two points (step of space) of the corresponding graph.

CFL: It is a question of determining the coefficient of CFL, value between 0 and 1. From this coefficient, the program will calculate the step of time associated in the resolution of the diagram.

Fo, Zo, Alpha, Beta, Re: These are coefficients whose definitions are given in the picture of the preceding window:

$$Fo = \frac{U}{\sqrt{gH}} \quad ; \quad \alpha = \frac{Zo}{H} \quad ; \quad \beta = \frac{Zo}{L}; \quad R_e = \frac{HU}{\mu}$$

Stage 2 : Control and action



Frame of control and action

What do you want to do? : You have the choice between keeping simulations carried out in a file or simply to post with the screen a graph or a film following the graphics options which you wished. By default, it acts of a drawing of H (height of water). If you choose to save the files which you simulate, it will be saving in the repertory save_plots (**SVS_Logi/svk_v4/save_plots**). The names running are as follows: if you only choose to make graphs, the names of the data are « Htime.gif », « Ftime.gf » and « Qtime.gif ». In the case of a film, the different pictures given made up this film are numbered in the order of their appearance. Indeed, that will make it possible to easily index the logical order in which they appear with the image.

Previous: That makes it possible to retrogress in simulation. All the preceding parameters are in preserved facts. It will be to you in fact completely possible considering the configuration of the software to change one or more parameters in simulation and to start again a test without having to leave the window.

Go: run your choice.

Exit: To support on exit makes it possible to leave this menu and to join the main menu. All the data entered in this case will be lost. The data concerning the options of the type numerical or graphic are however preserved.

Frequently Asked Questions

- I try to make a graph and when I click on **Go** in the window of control, the software gives me an error saying that it does not know **"/usr/local/bin/gnuplot** "or any other way.

There are several possible reasons with this problem. It may be first of all that you forgot to fill the path of gnuplot in small Graphics Options. If gnuplot is not installed at this place, it thus did not connait the access. This can be the case if any other way given does not exist and does not allow calling the order gnuplot.

- I want to make a film in order to see the evolution of a phenomenon in the course of time. Unfortunately, an error intervenes when I support on **Go** by writing "ambigous or unknown type of data".

Check that you installed the library provided in the pack in order to create GIF images. If it isn't the case refer to the heading installation of the handbook.
If this library is installed, open the way running towards gnuplot (for example write /usr/local/bin/gnuplot in a terminal) then write « set terminal ». Check whereas in the possible list of the exits of gnuplot format gif appears. If it is not the case, your version of gnuplot did not take into account the bookshop installed.
If that still does not go to close the software and open a new window by giving another path.

- I have just changed the data concerning Graphics Options and the window of control did not change. I am thus not sure that the sunken data are taken into account.

The last window of a case, i.e. control window sets up the parameters of simulation and only these data are taken into account. So that the new data are effective, it is necessary to click on "Previous" and then on "Next". You will then see a change in the parameters.

- The program plants, the terminal turns unceasingly and does not stop any more and I cannot close the software.

Don't panic! It is surely about a problem which has occurred when you entered the number of points the case of a grid not uniform. The only the solution is to quit the terminal

- The program blocks me the access to a window and prevents me from continuing my experiment (as well an option or a case to be tested).

Check first that there isn't already a window in progress with the same aim. If it is not the case, it is possible whereas you have to leave a window by the cross in the right higher corner of the window and not by the « Exit » button which is located in bottom of the page.
We recall you that in order to avoid this kind of errors always want when the Exit button exists to close a window using this button.

Bibliograpic references

1) A.-J.-C. de Saint-Venant, Théorie du mouvement non-permanent des eaux, avec application aux crues des rivière et à l'introduction des marées dans leur lit, C.R. Acad. Sci. Paris 73 (1871), 147–154

2) G.A. Lawrence, Steady flow over an obstacle, J. Hydraul. Engng, ASCE, 113 (1987), no. 8, 981-991

3) R.J. Le Veque, Numerical methods for conservation laws, Lectures in Mathematics ETH Zurich, Basel, Birkhäuser, 1992

4) P.L. Viollet, J.P. Chabard, P. Esposito, D. Laurance, Mécanique des fluides appliquée, Presses des Ponts et Chaussées, Paris, 1998

5) K. Lowery, S. Liapis, Free-surface flow over a semi-circular obstruction, Internat. J. Numer. Methods Fluids, 30 (1999), 43-63

6) B. Perthame, C. Simeoni, A kinetic scheme for the Saint-Venant system with a source term, Calcolo 38 (2001), no. 4, 201–231

7) M.O. Bristeau, B. Coussin, Boundary conditions for the shallow water equations solved by kinetic schemes, INRIA Report, 4282 (2001)

8) O. Pouliquen, Y. Forterre, Friction law for dense granular flows: application to the motion of a mass down a rough inclined plane, J. Fluid Mech., 453 (2002), 133–151

9) F. Vigie, O. Eiff, D. Astruc, Experimental study of the flow regimes of sub-critical channel flow over an obstacle, submitted to Riverflow 2002

10) A. Mangeney, J.-P. Vilotte, M.O. Bristeau, B. Perthame, F. Bouchut, C. Simeoni, S. Yerneni, Numerical modeling of avalanches based on Saint Venant equations using a kinetic scheme, J. Geophys. Res. 108 (2003), no. B11, 2527–2544

11) Th. Katsaounis, C. Simeoni, Second order approximation of the viscous Saint-Venant system and comparison with experiments, Hyperbolic problems: theory, numerics, applications, 633–644, Springer, Berlin, 2003